CAPACITY TEST OF A THREE TON YORK ICE PLANT

BY

W. W. SIR
R. BOHN
G. COOLEY

ARMOUR INSTITUTE OF TECHNOLOGY

1914

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Economy and capacity test of
a three ton York ice plant

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ECONOMY AND CAPACITY TEST OF A THREE TON YORK ICE PLANT

A THESIS

PRESENTED BY

WALTER WALDEMAR SIR
ROBERT BOHN
GILBERT COOLEY

TO THE

PRESIDENT AND FACULTY

OF

ARMOUR INSTITUTE OF TECHNOLOGY

FOR THE DEGREE OF

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

HAVING COMPLETED THE PRESCRIBED COURSE OF STUDY IN

MECHANICAL ENGINEERING

MAY 28, 1914

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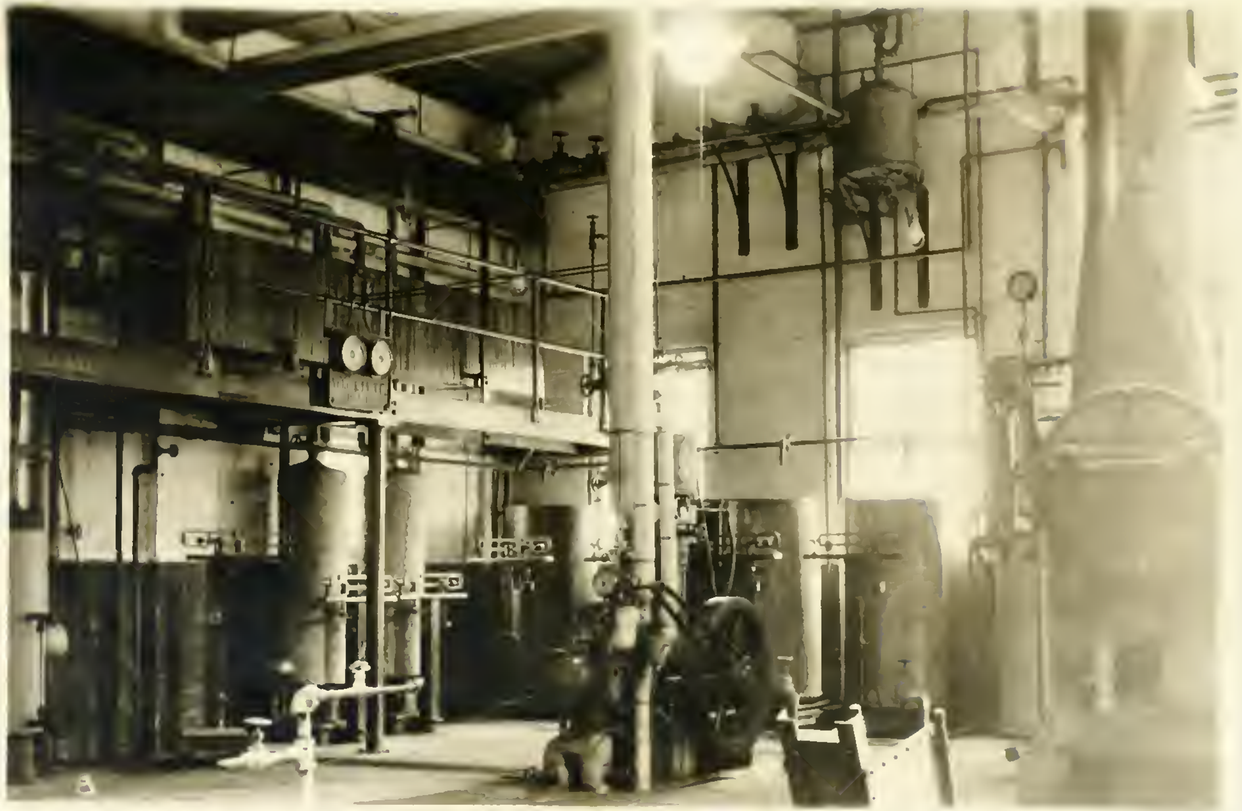


Interior of Plant

OBJECT

The object of this test was to determine the economy and capacity of the York Refrigeration Plant, installed in the Dearborn Street Laboratory of the Armour Institute of Technology, for making distilled water ice, the distilled water being obtained by condensing under atmospheric pressure, the exhaust steam from the compressor engine and the plant auxiliaries.

PLANT DESCRIPTION

The plant, which is the subject of this test and report, is located in a one-story, brick building at Dearborn and 33rd Streets, Chicago, Ill., and is a part of the Mechanical Laboratory of Armour Institute of Technology. The plant is equipped with a twenty horse-power Erie Economic boiler, of the return tubular type, having a heating surface of 165 sq. ft. and a grate surface of 10.5 sq. ft. The draft is natural and supplied by a 18"x35' steel stack. Safety appliances are according to Chicago Specifications. Feed water is supplied by a Worthington Duplex feed pump, or by a Metropolitan injector.

The Engine is a horizontal simple slide valve engine, having a bore and stroke of 6". The single acting 6"x6"

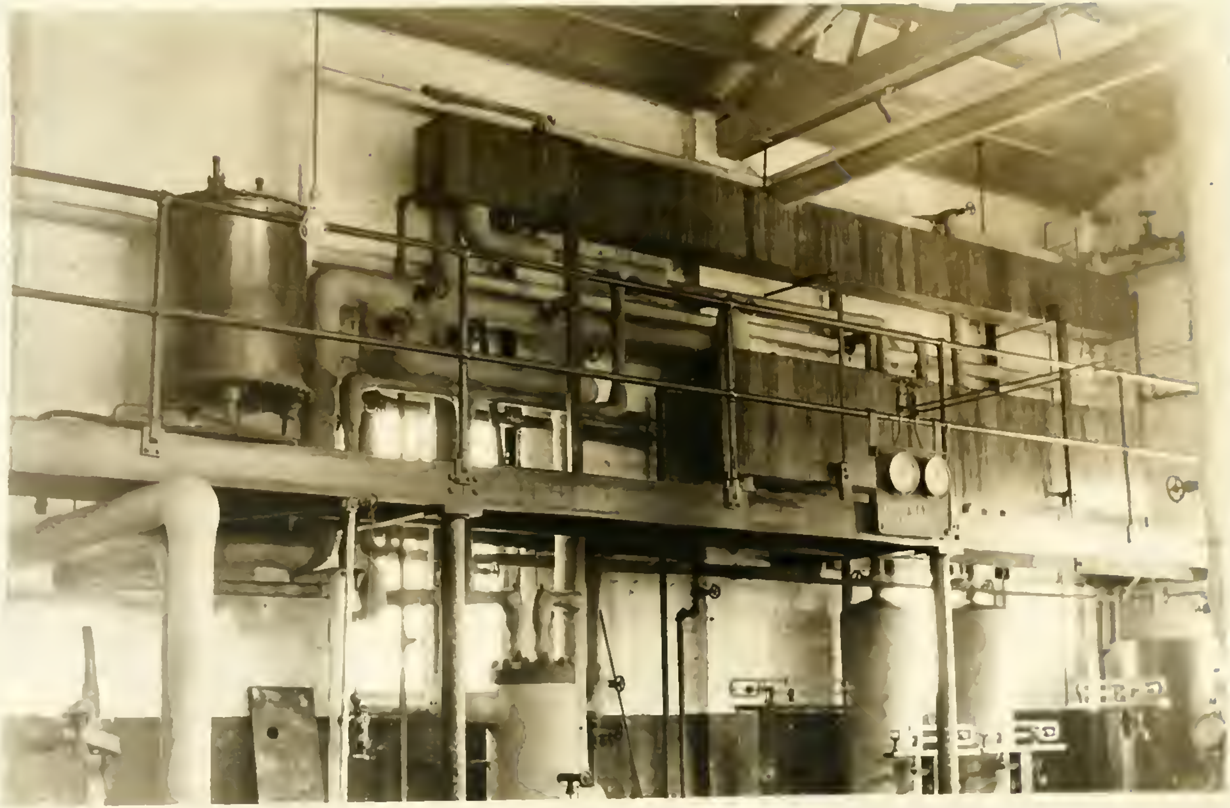
Compressor

York Compressor is directly connected to the engine. The Compressor operates with zero clearance and is provided with a false head, held down by a heavy car spring. In case a slug of liquid enters the Compressor, the false head raises and prevents damage to the Compressor. The discharge valve is located in the false head and the suction valve in the piston. Cooling is by an open waterjacket of the overflow type and supplied with city water. Both engine and compressor are fitted with reducing motions and indicator connections. Lubrication of the compressor is by a hand force feed lubricator and the engine by a hydrostatic lubricator. All other lubrication is by sight feed oilers.

The Ammonia Condenser is of the double pipe type, consisting of one bank of 1-1/4" pipes inside of 2" pipes, all enclosed in a wooden box and thoroughly insulated with ground cork. The exhaust steam condenser is also of the double pipe type and consists of one bank of 1-1/4" pipes inside of 2" pipes. This condenser is used only to obtain water for distilled water ice and is under atmospheric pressure.

The Ammonia gas is discharged from the compressor through an oil separator to the double pipe Ammonia condenser. The gas is condensed to a liquid and the liquid is piped to one of two receivers, which are both mounted on platform scales and connected in series so that while one receiver is filling from the condenser, the

Freezing Tank



Showing Gallery and NH_3 Condenser

other is discharging into the ammonia line to the expansion valve. The expansion valve is just above the freezing tank and expansion is direct into the freezing tank. The ammonia leaving the expansion coils in the freezing tank, as a gas, is pumped back to the compressor and the cycle repeated. An accumulator in the liquid line was not used.

The distilled and filtered water for ice making is obtained by condensing the exhaust from the engine and auxiliaries. The exhaust header leads first to an oil separator, then to the double pipe condenser where the exhaust steam is condensed. The condensate then gravitates to the reboiler where it is reboiled and skimmed. The water is then re-cooled by a double pipe re-cooler and then passed through a York filter to the storage tank.

A Duplex Brine Pump circulates the brine in the freezing tank by having a suction header in one end of the tank and discharge header at the surface of the opposite end. The brine tank is 14'x5'3"x3'6" deep, constructed of sheet steel. The insulation is by 6" of cork on sides and bottom. Provision is for 35, 100# ice cans.

Frost on Brine Pump During Test

PIPING

Steam -

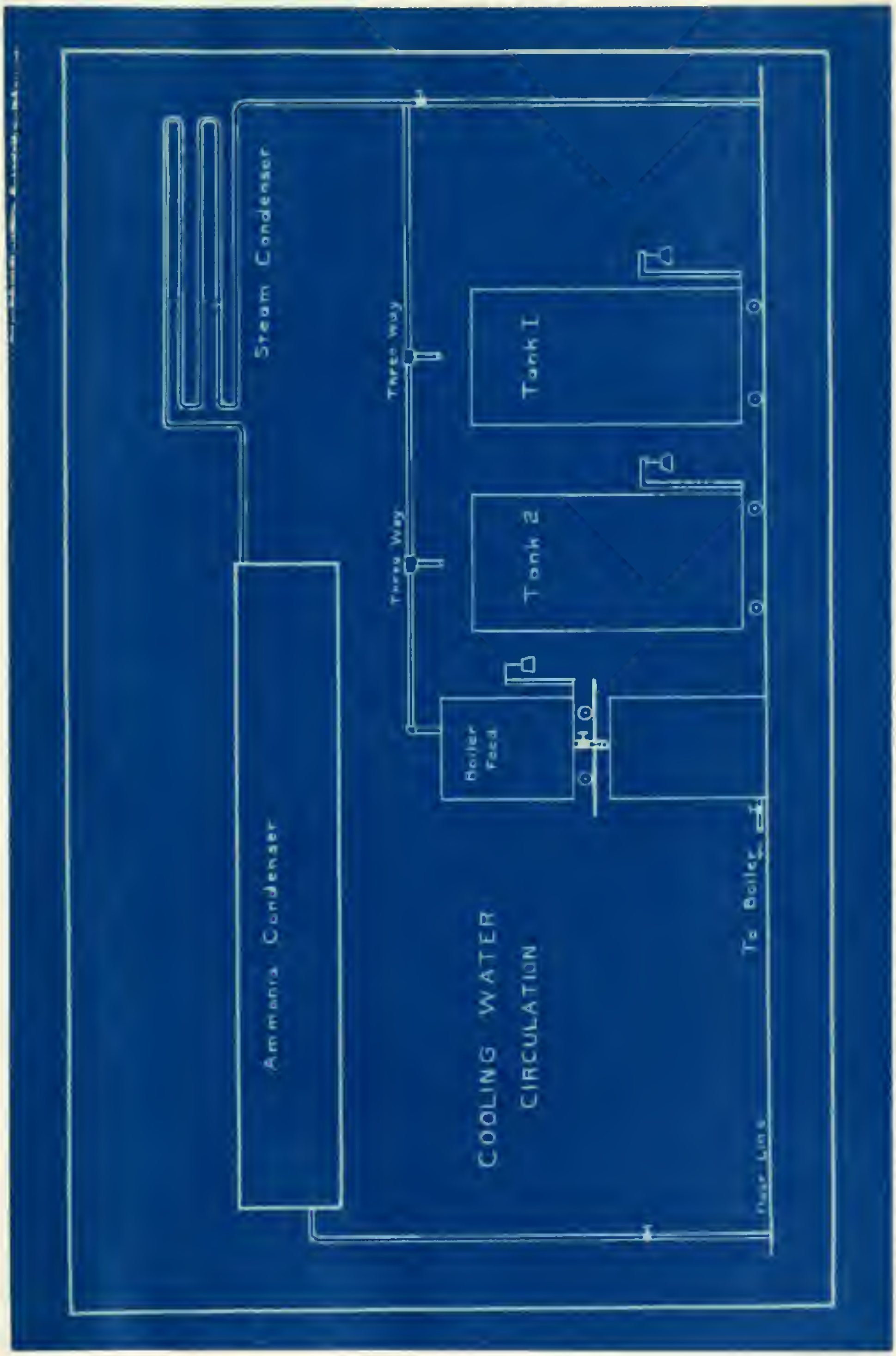
The steam header is 2-1/2" in diameter. The engine is supplied by a 1-1/4" pipe and the auxiliaries by 1" pipe. The re-boiler is connected from the steam header by a 1/2" pipe.

Exhaust -

Exhaust is by a header to the atmosphere, to a Wheeler Surface Condenser, or to the Atmospheric Condenser as desired.

Water -

Water is supplied from the city mains and passes first over the Ammonia Condenser, then to the Exhaust Steam Condenser, to weighing tanks and then to the sewer or as is needed to the boiler feed. An independent cold water line supplies the distilled water cooler.


Steam Condenser
Three Way
Three Way
Tank I
Tank 2
Boiler Feed
Ammonia Condenser
COOLING WATER CIRCULATION
To Boiler
Flow Line

AVERAGE DATA, OBSERVED OR COMPUTED

1. Duration of Test, hours----------78.

Dimensions, Volumes, etc.

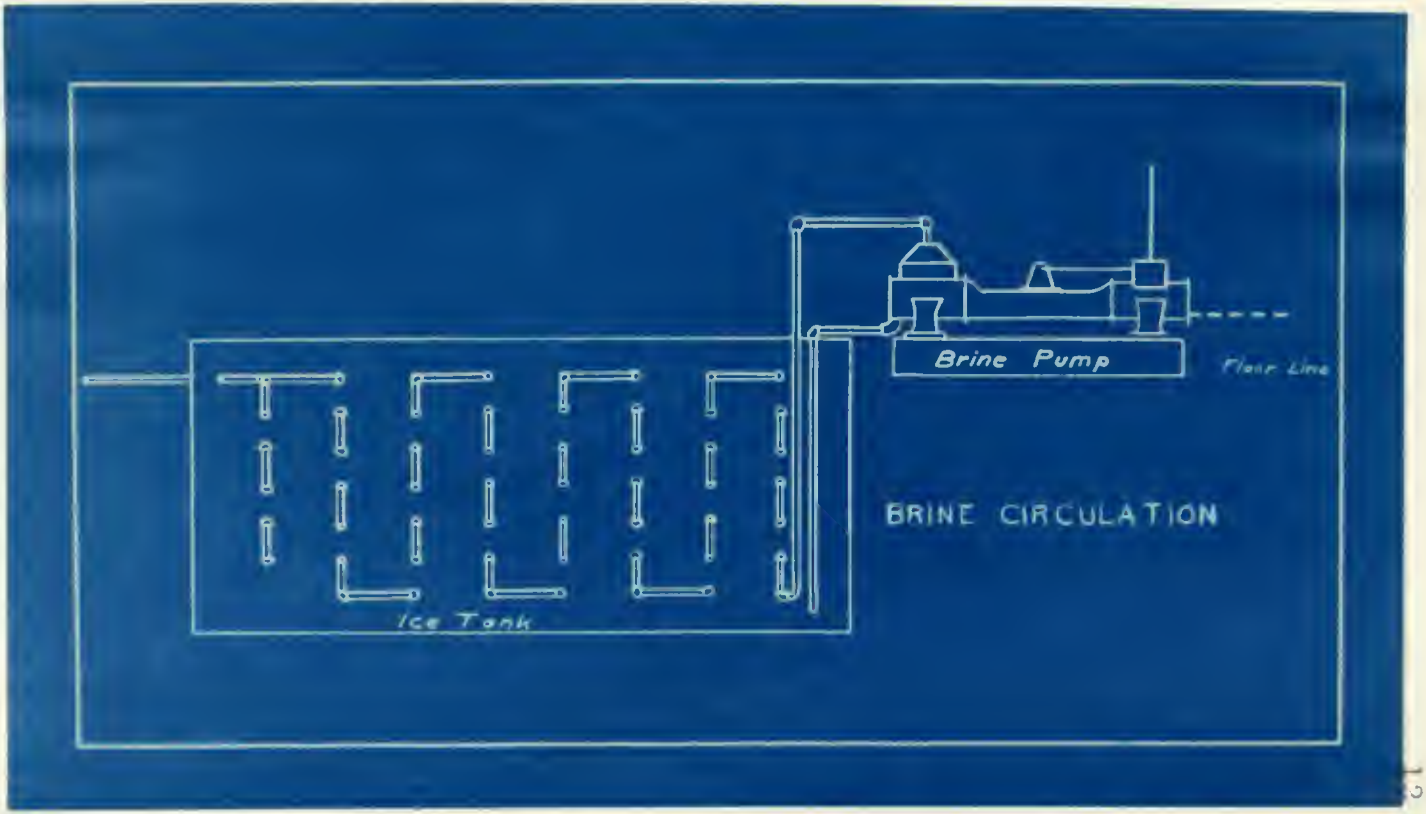
2. Dia. Steam Cyl., inches---------- 6.
3. Stroke " " " ---------- 6.
4. Dia. Piston rod, steam cyl., inches---------------------------- 1-1/2
5. Area Steam Cyl. head, sq. inches-28.27
6. " " " crank, " " 26.51
7. Dia. Compressor Cyl., inches----- 6.
8. Stroke " " " ----- 6.
9. Piston displacement compressor, cu. feet--------------------------- .98
10. Dia. Brine Pump, inches---------- 3.5
11. Stroke " " " ---------- 5.
12. No.cylinders brine pump---------- 2.
13. Piston displacement per cyl. brine pump, cu. feet---------------- .27

Revolutions per Minute

14. Steam engine-------------------145.
15. Compressor---------------------145.

Pressures

16. Steam pressure at Boiler-------- 92.
17. " " " Engine-------- 47.5
18. Suction " Compressor---- 15.8
19. Disch. " "-------- 98.3
20. Barometer---------------------- 29.306



Brine Pump
Floor Line
BRINE CIRCULATION
Ice Tank

Temperatures, Deg. Fahr.

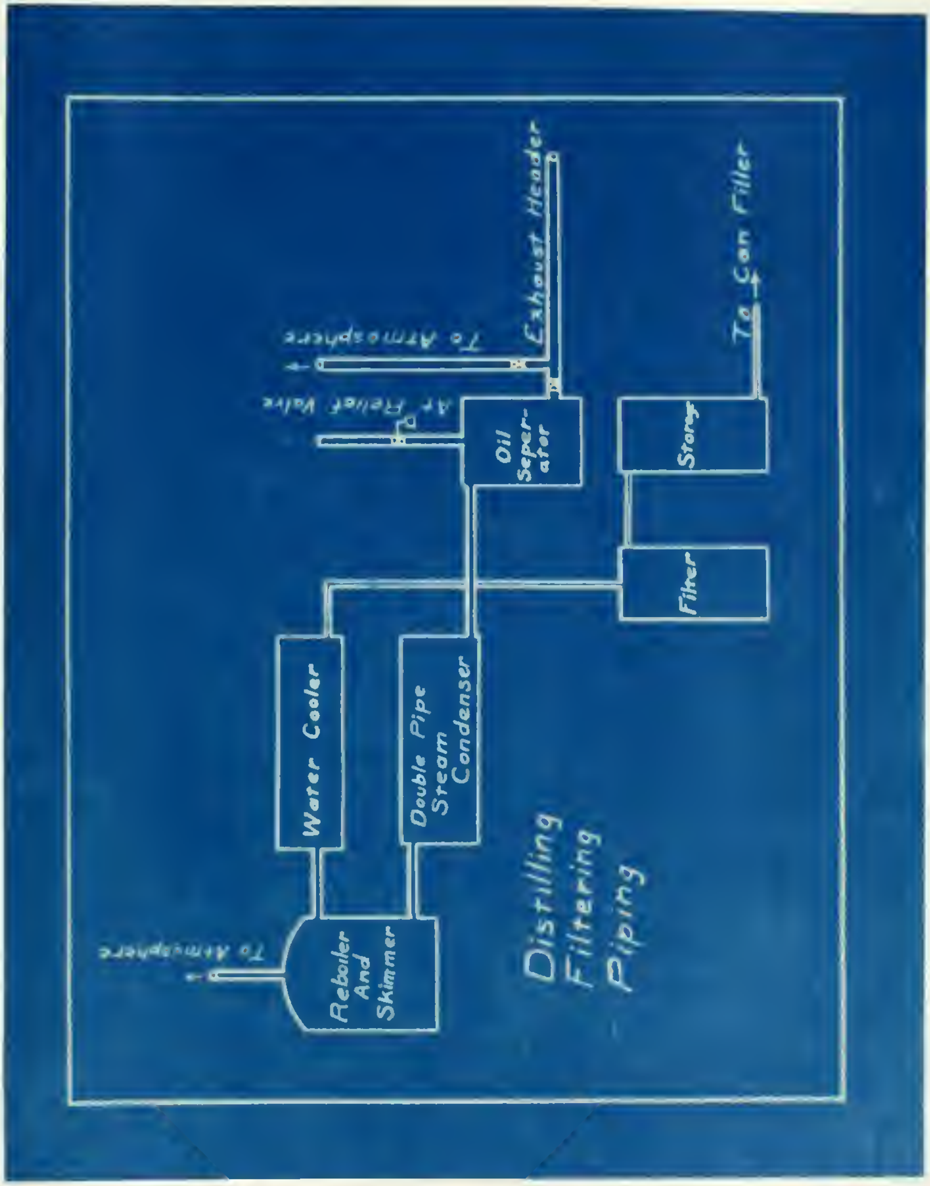
21. Room------------------------------ 66.
22. Temp. in Calorimeter at Boiler--246.
23. " " " " Engine--213.
24. Suction Temp. Compressor-------- 12.
25. Disch. " " --------121.3
26. Condensing Water NH_3 Condenser inlet------------------------------- 46.
27. Condensing Water NH_3 Condenser outlet------------------------------ 55.
28. Temp. NH_3 inlet to Condenser---- 95.6
29. " " outlet from " ---- 49.6
30. " of brine inlet to freezing tank--------------------------------- 6.60
31. Temp. of brine outlet of freezing tank----------------------------- 8.97
32. Temp. of NH_3 leaving freezing tank--------------------------------- 5.37
33. Temp. of Feed water to boiler---102.

Weights

34. Weight of water NH_3 Condenser, lbs.,---------- ----------------410926.
35. Weight of water Boiler Feed, lbs.,---------------------------- 33759.
36. Weight of NH_3 circulated,lbs. 5106.
37. " " Coal burned, lbs.-- 6360.
38. " " Ash, lbs.---------- 716.
39. " " Ice, lbs.---------- 11293.

General

40. Quality of Steam at Boiler------ 95.
41. " " " " Engine------ 91.8



Distilling Filtering Piping

FINAL RESULTS

Steam Engine

43. I.H.P.-------------------------- 3.41
44. Water Rate per I.H.P. hr. from indicator card----------------------13.8
45. B.T.U. supplied per hr.

Compressor

46. I.H.P.-------------------------- 2.81
47. B.T.U. hour equiv. I.H.P.----7157.
48. Apparent volumetric Eff.--------98%
49. Piston displacement, cu. ft.--- .98
50. Sp. vol. NH_3 at suction, press. and temp.
51. Wt. NH_3 per stroke, lbs.------- .0081
52. " " " hour, " -------71.

Condenser

53. Weight of water per hr., lbs.5707.
54. Range of temp., water, deg.---- 9.
55. B.T.U. per hr. in condensing water---------------------------51363.
56. Total heat removed from each lb. NH_3, B.T.U.------------------- 583.3
57. Heat removed from NH_3 per hr. B.T.U.----------------------------41473.3

Freezing Tank

58. Range of Temp. Brine-------- 2.37
59. B.T.U. per hr. from Brine---22586.
60. " " " to NH_3

General Results

63. Tons of ice per ton of coal------ 1.775

64. " " " " I.H.P. steam---- .604

65. " " " " " NH_3------- .497

66. Mechanical Eff. of set ----------82.1%

67. Actual coefficient of performance 3.15

68. Ideal " " " 11.7

69. Efficiency of ref. process-------26.9%

70. Tonnage-------------------------- 1.88

HEAT BALANCE

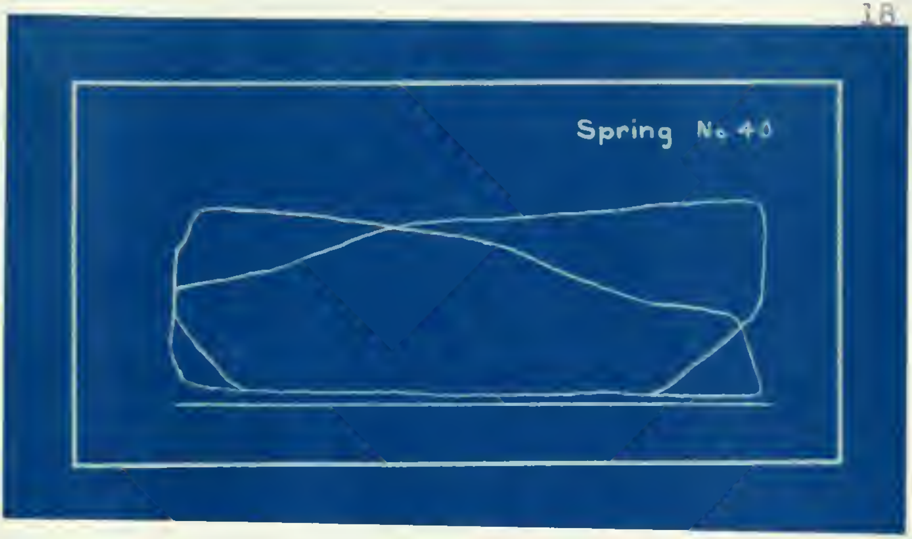
A. - Heat received by cooling agent per hr.

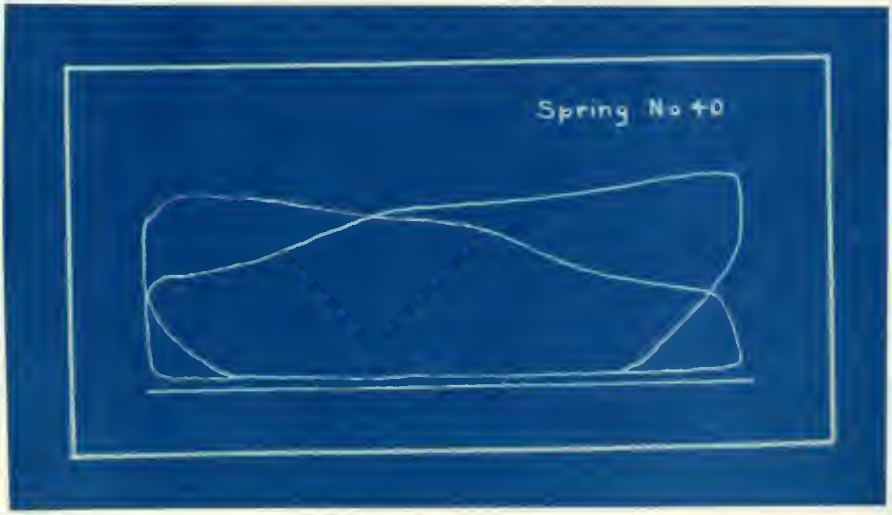
1. Heat taken from brine---22586. B.T.U.
2. " equiv.compressor I.H.P.---------------------- 7157. B.T.U.
3. Heat by radiation (by diff.)-----------------------11670.3 B.T.U.

41413.3 B.T.U.

B. - Heat given up by agent per hr.

1. Heat removed in condenser - - 41413.3 B.T.U.


Spring No. 40


Spring No. 40

CALCULATIONS

43. I.H.P. (Engine) $= \frac{PLAN}{33000}$

$$= \frac{28 \times 1/2 \times 28 \times 290}{33000} = 3.41$$

44. Water Rate (Theoretical)

$$Wr = 13750 \frac{W}{P} = 13750 \frac{.03806}{28} = 18.8$$

W = wt. 1 cu. ft. steam at exhaust pressure.

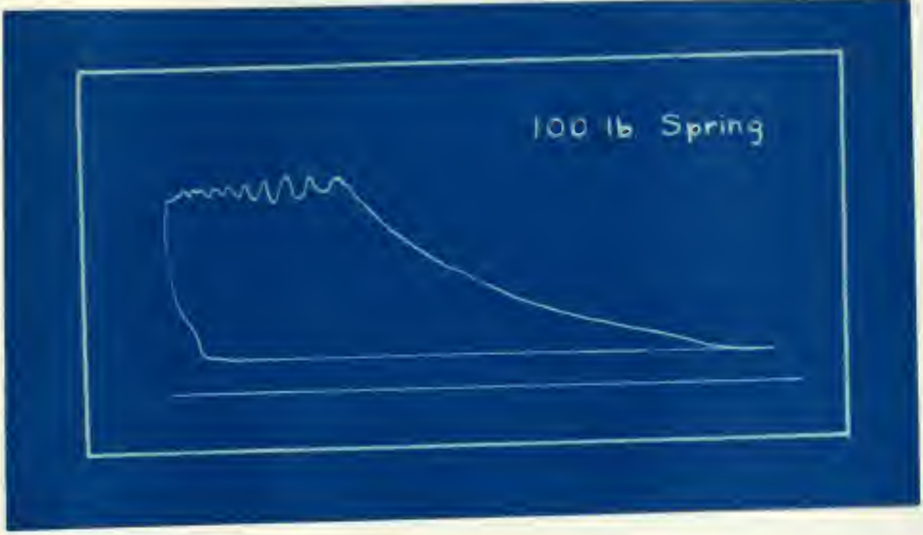
P = M.E.P.

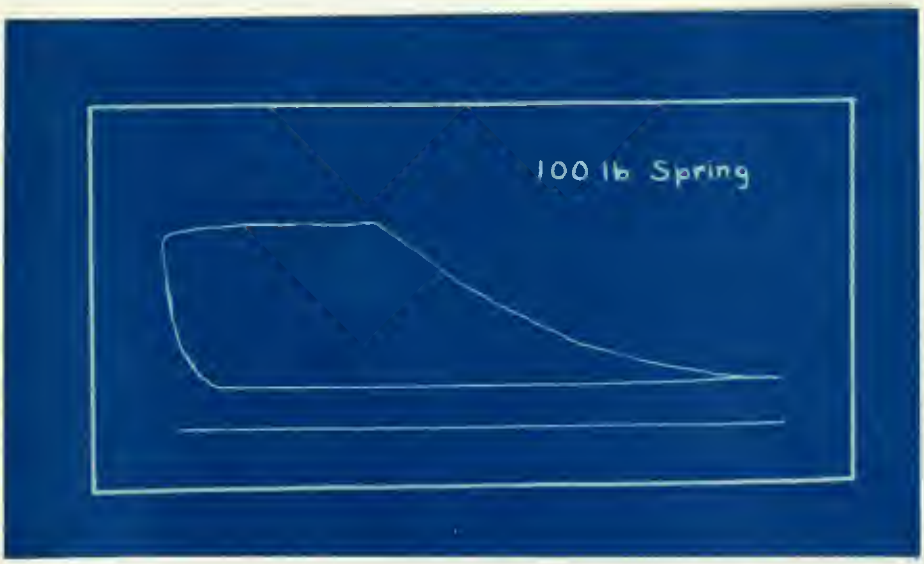
46. I.H.P. (Compressor) $= \frac{PLAN}{33000}$

$$= \frac{45.7 \times 1/2 \times 28 \times 145}{33000} = 2.81$$

47. B.T.U. per hr. equiv. Cond. I.H.P.

$$= 2547 \times 2.81 = 7157 \text{ B.T.U.}$$


100 lb Spring


100 lb Spring

48. Apparent Vol. Eff. from average Card

$$E = \frac{\text{Card Area}}{\text{Card Area} + \text{Clearance Vol. as shown on Card}}$$

$$= \frac{1.51}{1.53} = 98\%$$

49. Piston Displacement Compressor

$$= \frac{3.1416 \times (1/2)}{4} \times 1/2 = .98 \text{ cu. ft.}$$

50. Spec. Vol. NH_3

51. 145 R.P.M.

145 x 60 = 8700 Strokes per hr.

$$\frac{71\# \ NH_3 \text{ per hr.}}{8700 \text{ Strokes per hr.}} = .0081\# \ NH_3 \text{ per stroke}$$

52. $\frac{5106\# \text{ Total}}{72 \text{ hrs.}} = 71\# \ NH_3$ per hr.

53. Total cooling water 410,926#

$$\frac{410926}{72 \text{ hrs.}} = 5707\# \text{ per hr.}$$

54. $55^\circ - 46^\circ = 9^\circ$ Fahr.

55. $9^\circ \times 5707\# = 51363$ B.T.U. in condensing H_2O

56. 1) $H_1 = .508\ (46) = 23.3$ Cooling Gas

2) $H_2 =$ Latent heat $= 514.$ Latent Heat

3) $H_3 = 1\ (46) \qquad = \underline{46.}$ Cooling Liquid

583.3 Total heat removed from $1\#\ NH_3$

57. Heat removed from NH_3 per hr.

$583.3 \times 71 = 41,413.3$

58. $8.97^\circ - 6.60^\circ = 2.37^\circ$

59. 11293# ice in 72 hrs.

$\frac{11293 \times 144}{72} = 22586$ B.T.U. Removed from Brine.

63. $\frac{11293\#\ \text{ice}}{6360\#\ \text{coal}} = 1.775$ Tons ice per ton of coal.

64. $\frac{11293\#}{2000} = 5.64$ Tons

$\frac{3.41 \text{ HP}}{5.64 \text{ Tons}} = .604$ Tons of ice per I.H.P. Steam.

65. $\frac{2.81}{5.64} = .497$ Tons of ice per I.H.P. Compressor.

66. $\frac{2.81}{3.41} = .821 \times 100 = 82.1\%$ Mechanical Eff.

67. Actual Coef. Performance

$$Ka = \frac{\text{B.T.U. from Brine per hr.}}{\text{B.T.U. equiv. of work done per hr. by compressor}}$$

$$= \frac{22586}{7157} = 3.1$$

68. Ideal Coef. of Performance

$$\frac{T_2}{T_1-T_2} = \frac{468.9}{509-468.9} = \frac{468.9}{40} = 11.7$$

69. Efficiency of ref. process

$$\frac{3.15}{11.7} = .269 \times 100 = 26.9\%$$

70. Tonnage

$$\frac{22586 \text{ B.T.U. per hr.} \times 24 \text{ hrs.}}{288000 \text{ B.T.U.}} = 1.88$$

Preliminary Run

Steam was first gotten up in the plant April 22nd, 1914, and aside from leaky gaskets, no trouble was experienced. The plant was run under full load for about six hours. Fire was drawn at 4:30 P.M.

Test

Steam was raised Monday morning, April 27th, 1914, and the compressor started about noon. The plant was run continuously until Saturday noon, May 2nd, 1914. No readings were taken until all the ice cans had been filled and frozen once. The Test was started at 6:00 A.M., April 29th, 1914, and readings taken every half hour for seventy-two hours.

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University of Illinois -
Bulletin #66

Catalogue -
York Mfg. Co.

RUNNING LOGS

#1

Time A.M.	Cont. Counter	PRESSURES Barometer	Boiler	Steam at Engine	Back	Condenser Ins. Hg	Ammonia Discharge	Ammonia Suction	WEIGHTS Coal	Ash	Feed Water	Jacket Water	Condensed Steam	Cooling Water	Brine	Ice	Ammonia	Time of Pulling	
6:00	0950	29.30	88	45			95	18	410							104	19	6:10	
6:30	4005		90	45			95	18			417					106	67.5	6:40	
7:00	9000		86	45			95	17								106	35	7:00	
7:30	3339		84	45			100	16			374					102	42	7:30	
8:06	6628		93	48			97	15								104		8:00	
8:30	0832		90	45			97	15	140.5		384					103.5		8:30	
9:00	4892		83	45			97	15								105.5	41	9:00	
9:30	9672		70	45			97	14		90.5	364					98	33	9:30	
10:00	3537		67	47			97	14	153.0							104	28.5	10:00	
10:30	7486		70	45			97	14			387					103.5		10:30	
11:00	1829		75	45			97	14								103		11:00	
11:30	4358		97	45			97	10			425					102.5		11:30	
12:00	8637		95	45			97									102		12:00	
																102		12:30	

Log Sheet No

Date Apr 29, 14

Shift 6AM–12M

Men on Shift

R. G. Bohn

L. C. Mayes

W. Goetz

G. L. Cooley

Stephanek.

TEMPERATURES

Room	Feed Water	Condensed Steam	Calorimeter		Jacket Water		Compressor Gas		Ammonia Condenser				Brine Around Ice Tanks		Brine Tank Ammonia Gas				
			Boiler	Engine	Inlet	Outlet	Inlet	Outlet	Gas	Liquid	Cooling Water Inlet	Cooling Water Outlet	Inlet	Outlet	Inlet	Outlet			
68	85		220	213			5	48	58	49	46	53.5	4	9		-1			
68	86		250	213.5			6	86	62	48	46	53.5	4	9		-1			
68	86		253	212			6	100	68.5	48	46.5	55	4	9		-2			
68	84		251	212			3	123	82	55	46	55	4	8		-6			
68	90		253	213			5	123	92	48	46	56	5	10		-5			
68	90		248	212			5	123	97	49.5	46	56	5	10		-5			
72	92		250	212			9	140	100.5	49.5	46	57				10			
72	144		254	212			12	148	105	48.7	46	56	5	10		13			
75	96		246	213			10	160	100.5	48.5	46	56	7	10		16			
76	96		241	212			18	162	107	48.0	46	55	6	8		16			
78	104		248	212			25	164	108	47.5	46	55	6	10		17			
78	99		250	212			28	167	110	47.5	46	54.5	2	9		18.5			
78	110		248	213			30	168.5	110	47.5	46	53	8	9.5		17			

#2

PRESSURES

Time	Cont. Counter	Barometer	Boiler	Steam at Engine	Back	Condenser Ins Hg	Ammonia Discharge	Ammonia Suction
12:30	7554	29.29	95	45			97	7.5
1:00	2225		94	45			97	12.5
1:30	5663		93	45			97	14
2:00	0406		90	47			97	15
2:30	1442		92	50			97	16
3:00	6087		85	50			97	18
3:30	9020		85	50			102	20
4:00	3758		95	50			105	23
4:30	7894		93	50			104	23
5:00	R.P.M.		95	47			104	20
5:30	145		75	45			104	17
6:00	144		75	45			103	12.5
6:30	144		80	48			100	15
7:00	144		105	50			103	18
7:30	144		75	47			103	18

WEIGHTS

Time	Coal	Ash	Feed Water	Jacket Water	Condensed Steam	Cooling Water	Brine	Ice	Ammonia	Time of Pulling	
12:30	154.5								36.5		
1:00								103.5	45.5	1:00	
1:30								103.5	51	1:30	
2:00								102.5	49	2:00	
2:30	167.5							102	52.5	2:40	
3:00								104.5	43.	3:30	
3:30								103	6	4:19	
4:00	54.5	65.5						103	51	4:40	
4:30								101.5	75	5:15	
5:00								103.5	66	5:50	
5:30	200							105	38.5	6:30	
6:00								105	51	7:10	
6:30								104	45	7:50	
7:00	172							103.5		8:30	
7:30								103.5		9:10	

Log Sheet No
Date Apr 29, 14
Shift 12M-4PM
Men on Shift
G. S. Cooley
W. W. Sn.

TEMPERATURES

Room	Feed Water	Condensed Steam	Calorimeter		Jacket Water		Compressor Gas		Ammonia Condenser				Brine Around Ice Tanks		Brine Tank Ammonia Gas			
			Boiler	Engine	Inlet	Outlet	Inlet	Outlet	Gas	Liquid	Cooling Water Inlet	Cooling Water Outlet	Inlet	Outlet	Inlet	Outlet		
78	116.5		230	212			30	161	108	47.5	46	55	8.5	12		19.5		
69.5	112			210.5			36.5	148	106	48	46	56	9	13		20		
69	112			211			18	156	107	48.2	46	56	9	11		19		
69	105.5			210			36	140	107	49.5	46	56	9	10		20.5		
69	100			211			35.5	134	110	56.5	46	56	10	11.5		17		
69	104.5			212			34.5	132	110	55.5	46	58	10	11		15		
69	98			212			5	124	106	57	46	57	10	12		14		
67	107			211.5			3	162	88	52	46	58	10	12.5		4		
68	106			211			4	161	72	50.5	46	59	10	13.		8		
69	106			211			3	113	83	47.5	46	58.5	9	12.5		6		
67.5	106			211			12	122	93	47	46	56	10	11		13		
67	106			211			11	125	95	47	46	55	8	14		20		
67	102			211.5			17	136	99	49	46	56	9	12		19		
67	104			212			23	136	103	51	46	57	10	12		19		
68	102			212			28	123	103	49	46	57	10	12		19.5		

#3

		PRESSURES							WEIGHTS										
Time	Cont. Counter	Barometer	Boiler	Steam at Engine	Back	Condenser Ins. Hg	Ammonia Discharge	Ammonia Suction	Coal	Ash	Feed Water	Jacket Water	Condensed Steam	Cooling Water	Brine	Ice	Ammonia	Time of Pulling	
8:00	144	2929	80	50			103	18											
8:30	144		80	50			103	18	138.8										
9:00	145		88	50			103	18											
9:30	145		88	50			102	20								103	26.5	9:50	
10:00			86	50			100	20	184								65.5		
10:30	144		85	50			102	20								.06	49	10:30	
11:00			90	50			100	21									38		
11:30	144		95	52			100	22.5									45		
12:00			95	52			97	23	187							106	54	11:10	
12:30	144		92	52			97	22.5									60		
1:00			95	52			97	20								105	21	12:40	
1:30	145		93	48			97	17	189								36		
2:00			89	48			97	18								103	63.5	1:40	
2:30	145		88	48			97	18									40.5		
3:00			96	48			97	19								103.5	23	3:00	

Log Sheet No
Date 4.29 – 4/30
Shift
Men on Shift
Cooley
Ari. 4 P.M.
BOHN 12 M.

TEMPERATURES

Room	Feed Water	Condensed Steam	Calorimeter		Jacket Water		Compressor Gas		Ammonia Condenser				Brine Around Ice Tanks		Brine Tank Ammonia Gas			
			Boiler	Engine	Inlet	Outlet	Inlet	Outlet	Gas	Liquid	Cooling Water Inlet	Cooling Water Outlet	Inlet	Outlet	Inlet	Outlet		
67	104		230	212			30	121.5	102	50	46	57	16	12		15		
68	.03		242	212			31	122	101	51	46	56	10	12		19		
65	102		234.5	211.5			31	122	102	51	46	57	10	13		22		
66	104		220	212			29	122	103	53	46	57	9	11		7		
64.5	102		236	210.5			18	118	102	57	46.5	57	10	11		8		
64	102		242	210			14	100	100	52	50	57	10	11		3		
60	98		244	210			3	72	78	52	52	57	10	11		4		
60	96		240	210			5	66	80	46	46.5	56	10	12		4		
63	96		232	210			4.5	86	73	46	46	57	10	12.5		4		
62	94		240	210			5	86	84.5	47	46	56	10	13:00		4		
61.5	94		242	210.5			5	110	91	49	46	56	10	13		4		
62	94		239	211			5	116	93	47	46	55	10	11		4		
61	94		240	211			7	118	96	47.5	46	54.5	10	11		4		
61	94		240	211			7	120	97	48.5	46	55	95	11		15		
61	92		242	211.5			4	126	100	49	46	55	85	10		17		

#4

PRESSURES

Time	Cont. Counter	Barometer	Boiler	Steam at Engine	Back	Condenser Ins. Hg	Ammonia Discharge	Ammonia Suction
3:30	145	29.29	95	48			97	19
4:00			89	49			97	20
4:30	145		97	49			97	19
5:00			98	48			97	19
5:30	144		98	50			97	19
6:00			100	49			97	17
6:30		29.30	99	49			102	20
7:00	145		75	48			97	17
7:30			97	48			97	17
8:00			98	48			97	17
8:30	144		97	45			105	17
9:00			102	50			100	16
9:30	144		91	50			97	16
10:00			87.5	49			100	16
10:30			85	50			102	16

WEIGHTS

Coal	Ash	Feed Water	Jacket Water	Condensed Steam	Cooling Water	Brine	Ice	Ammonia	Time of Pulling
184								52	
	81							41	
								35	
								44	
								92	
								25	
200									
							101	28	7:15
								25.5	
							101.5	51.5	9:45
	48						102	33	10:20
							104	71.5	10:55
							104	44	11:30
							107	25	12:05
							103	28	12:40

Log Sheet No
Date 4/30 - 4/30
Shift
Men on Shift
Bohn
Cooley

TEMPERATURES

Room	Feed Water	Condensed Steam	Calorimeter		Jacket Water		Compressor Gas		Ammonia Condenser				Brine Around Ice Tanks		Brine Tank Ammonia Gas	
			Boiler	Engine	Inlet	Outlet	Inlet	Outlet	Gas	Liquid	Cooling Water Inlet	Cooling Water Outlet	Inlet	Outlet	Inlet	Outlet
61	90	2	240	211			2	112	101	52	46	55	8	16		3
60	90		241	211			0	112	94	51.5	46	55	7.5	11.5		2
60	89		242	211			0	100	86	49	46	55	7.5	9.5		1
59	88		242	211			1	114	66	57	46	55	7.5	9.5		2
59	86		241	211			1	115	74	50	46	55	6	8		1
58	84		241	211			1	114	85	50	46	55	5	8		-2
59	84		240	211.5			-1	114	85	52	46	55	4.5	8		-3
58	85			211			-1	126	91	49	46	55	4	7		-3
58	84			211			-1	128	92	53.5	46	55	3.5	5		-5
58	83			211			-3	130	94	55	46	55	3	5		-4
58	86			211			-3.5	61	89	52	46	58	3.5	4		-4
59	99			211			-3	60	74	53	46	58	4.5	4.5		-2.5
61	100		244	210			-3	64	71	52	46	58	3.5	4		-3
62	106		259	211.5			-3.5	72	71	53	46	58	3.5	5		-3
62	110		260	211			-4	110	81	60	46	58	3.5	5		-3

#5

		PRESSURES							WEIGHTS										
Time	Cont. Counter	Barometer	Boiler	Steam at Engine	Back	Condenser Ins. Hg	Ammonia Discharge	Ammonia Suction	Coal	Ash	Feed Water	Jacket Water	Condensed Steam	Cooling Water	Brine	Ice	Ammonia	Time of Pulling	
11:00	1167	29.30	85	50			102	15		38						106	27	1:15	
11:30	5349		92	50			100	15								105	65	1:50	
12:00	9285		97	47			98	15	200							103	58.5	2:25	
12:30	3675		100	47			101	13								104	28	3:00	
1:00	5638		100	45			97	10									34.5		
1:30	8076		85	45			98	9											
2:00	9864		100	50			96	9											
2:30	4133		102	47			97	12											
3:00	8544		100	44			95	13											
3:30	3920	29.29	100	46			95	13								105	53	3:35	
4:00	7234		95	46			97	15.3								103	31	4:10	
4:30	1321		95	46			96	15.1								105	44	4:45	
5.00	5699		100	47			95	15								105	45	5:20	
5:30	0163		95	48			97	12	138							105		5:55	
6:00	4528		95	43			97	8								105		6:36	

Log Sheet No

Date 4/30-4/30

Shift

Men on Shift

Bohn

cooley

Lu

TEMPERATURES

Room	Feed Water	Condensed Steam	Calorimeter		Jacket Water		Compressor Gas		Ammonia Condenser				Brine Around Ice Tanks		Brine Tank Ammonia Gas				
									Gas	Liquid	Cooling Water								
			Boiler	Engine	Inlet	Outlet	Inlet	Outlet			Inlet	Outlet	Inlet	Outlet	Inlet	Outlet			
64	113		259	211			-3.5	118	87	53	46	58	4.5	5.5		-4			
67	113		258	211			0	130	94	50	46	58	4.5	5		-5			
64	112		265	211.5			6	142	99	48	46	58	4.	5.5		-3.5			
63.5	118		265	211.5			9	116	99	47	46	58	4	5		2.5			
61.5	119		261	211.5			15	129	98	47.5	46	56	4	6		8			
61.5	116		254	211.5			15	141	99.5	47.5	46	56	5.5	6		10.5			
61.5	118		254	211.5			15	148	100	47	46	56.5	6	7		13			
61.5	114		250	211			15	133	102	48	46	56	6.5	8		15			
63	116		250	211			13	128	102	47	46	53.5	6.5	7		18			
65.5	112		254	211.5			15	127	102	47	46	54	6.5	7		18			
67	106		243	212			20	124	103	48	46	55	8	9		14			
63	108		260	212			19	124	104.5	48	46	56	7	10		-1			
65	98		228	212			15	123	104	49.5	46	56	8	9		-3.5			
66	98		220	212			15	122	102	47	46	54	8	9		4			
67	98		222	212			19	121	99	47	46	53	8.5	9		14			

#6

Time	Cont. Counter	PRESSURES							WEIGHTS										
		Barometer	Boiler	Steam at Engine	Back	Condenser Ins. Hg	Ammonia Discharge	Ammonia Suction	Coal	Ash	Feed Water	Jacket Water	Condensed Steam	Cooling Water	Brine	Ice	Ammonia	Time of Pulling	
6:30	8810	29.29	95	45			97	15								104		7:05	
7:00	2970		87	47			97	17								102	51.5	7:35	
7:30	8135		90	47			97	17								102	36.5	8:05	
8:00	2008		87	46			97	17	133							103	87	8:35	
8:30	6450		80	47			97	20								104	51	9:05	
9:00	0635		85	47			97	20								104	88	9:35	
9:30	5410		87	46			97	17	131							105		10:05	
10:00	8795		90	47			97	17								103		10:35	
10:30	3095		85	47			97	17	142							104		11:05	
11:00	7320		96	47			97	17								103		11:35	
11:30	1740		90	47			97	20	199							112.5	80.5	12.35	
12:00	5598		90	47			97	17								102		1:15	
12:30	0078		85	47			97	17								106	86	1:55	
1:00	4547		89	48			98	19								104.5		2:35	
1:30	8486		86	47			98	17	200							104	74.5	3:35	

Log Sheet No
Date 4/30-5/1
Shift
Men on Shift
Sir.
John

TEMPERATURES

Room	Feed Water	Condensed Steam	Calorimeter		Jacket Water		Compressor Gas		Ammonia Condenser				Brine Around Ice Tanks		Brine Tank Ammonia Gas				
			Boiler	Engine	Inlet	Outlet	Inlet	Outlet	Gas	Liquid	Cooling Water Inlet	Cooling Water Outlet	Inlet	Outlet	Inlet	Outlet			
65	104		220	212			22	122	100	47	46	54.5	8	10		18			
66	102		212	212			25	121	102	49	46	53	8	9		9			
68	102		212	212			18	121	103.5	51	46	55	9	10		0			
69	100		220	212			13	120	103	50	46	55	9	10		0			
68	100		220	212			2	103	100	50	46	55	8	10		2			
68	100		220	212			1	100	96	50	46	55	8	9.5		2			
68	98		212	212			1	114	96	51	46	55	8	11		1			
68	98		212	212			6	108	98	50	46	56	9	10		0			
66	98		212	212			9	118	99.5	49.5	46	56	9	10		0			
66	100		212	212			3	119	100	51.5	46	55	9	10		1			
66	98		212	212			3	102	98	51	46	55	8	9		2			
67	96		212	212			2	103	96	48	46	55	9	10		2			
66	98		215	212			4	118	98	48	46	55	9	11		5			
62	95		230	213			8	118	100	50	46	56	10	12		1			
61	94		230	213			9	118	100	49	46	56	10	13		0			

#7

Time	Cont. Counter	PRESSURES Barometer	Boiler	Steam at Engine	Back	Condenser Ins Hg	Ammonia Discharge	Ammonia Suction	WEIGHTS Coal	Ash	Feed Water	Jacket Water	Condensed Steam	Cooling Water	Brine	Ice	Ammonia	Time of Pulling	
2:00	2927		85	47			98	18								104.0		4:35	
2:30	7466		90	49			98	20		110						103	61	5:35	
3:00	2426		92	47			98	19								102		6:35	
3:30	6316		83	48			98	18	180							104	55	7:35	
4:00	0629		86	49			99	18								102			
4:30	4609		94	50			98	21								104			
5:00	8448		87	47			98	19											
5:30	3336		95	50			100	20									61		
6:00	7600		95	50			99	21									59		
6:30	1700		102	50			101	20											
7:00	6206		95	50			104	20	232								67		
7:30	0199		100	50			106	20											
8:00	4812		100	50			101	21									61		
8:30	9580	29.3	100	50			103	17								102	41.5	8:35	
9:00	3930		85	50			102	15											

Log Sheet No
Date 5/1/14
Shift
Men on Shift
Bohn
[illegible]
Kime.

TEMPERATURES

Room	Feed Water	Condensed Steam	Calorimeter		Jacket Water		Compressor Gas		Ammonia Condenser				Brine Around Ice Tanks		Brine Tank Ammonia Gas				
											Cooling Water								
			Boiler	Engine	Inlet	Outlet	Inlet	Outlet	Gas	Liquid	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet			
64	94		228	213			11	119	100	50	46	56	9	12		1			
64	92		228	213			4	80	99	50	46	56	11	12		3			
64	92		230	213			3	79	90	49	46	56	10	12		3			
64	92		230	213			3	80	77	49.5	46	56	10	11		3			
63.5	93		232	213			6	102	78	49	46	56	9	11		2			
64	92		230	213			6	108	86	53	46	56	8	11		1			
64	94		230	213			2	107	93	52	46	56	8.5	10		1.5			
63	93		230	213			1.5	110	97	53	46	56	8	10		2			
65	94		230	213			3	60	98	52	46	56	10	11		3			
66	92		230	213			4	80	82.5	52	46	55	8	10		2			
71	94		228	213			3	62	72	52	46	56	8	10		3			
71	94		228	213			6	61	75	53	46	55.5	8	10		3			
70	94		230	213			3	61	70	54	46	58	8	11		5			
71	99		220	213			4.5	114	84	49	46	57	6	9		-1			
69.5	102		250	212.5			8.0	128	97	48	46	56.5	7.5	8		3			

#8

Time	Cont. Counter	PRESSURES							WEIGHTS										
		Barometer	Boiler	Steam at Engine	Back	Condenser Ins. Hg	Ammonia Discharge	Ammonia Suction	Coal	Ash	Feed Water	Jacket Water	Condensed Steam	Cooling Water	Brine	Ice	Ammonia	Time of Pulling	
9:30	8316	29.3	88	50		1'	100	16								102	64	9:35	
10:00	2535		92	50			98	18											
10:30	6750		90	50			97	19	200							101	61	10:35	
11:00	0600		86	52			98	18											
11:30	4700		89	50			95	16								103	47	11:35	
12:00	8700		95	48			95	8		55									
12:30	3170		85	45			95	12								103	8	12:35	
1:00	7340		94	47			96	15											
1:30	1215		75	50			96	16								102.5	72.5	1:35	
2:00	4650		88	47			96	15	200										
2:30	7725		95				96	14								103	38	2:35	
3:00	1360		91	50			96	16											
3:30			79	50			93	17								103	62	3:35	
4:00			97	47			92	17									62.5		
4:30	144	29.306	95	47			95	17								101	44	4:35	

Log Sheet No

Date 5/1/14

Shift 8-4 P.M.

Men on Shift

J. S. Cooly

TEMPERATURES

Room	Feed Water	Condensed Steam	Calorimeter		Jacket Water		Compressor Gas		Ammonia Condenser				Brine Around Ice Tanks		Brine Tank Ammonia Gas				
									Gas	Liquid	Cooling Water								
			Boiler	Engine	Inlet	Outlet	Inlet	Outlet			Inlet	Outlet	Inlet	Outlet	Inlet	Outlet			
67	96		253	213			13	137	100	48	46	56.5	8	8		6			
65.5	106		251	212.5			15.5	141	104	48.5	46	55.5	7	8		11.5			
64.5	111		253	213			13	12.7	100	50	46	56	7	8		0.5			
63	102		248	212.5			2	129	102	58.5	46	54.5	7.5	8		1.0			
64	110		250	212.5			1	106	97.5	47	46	52.5	7.5	8		1.5			
64.5	110		254	213			4.5	118	98	47.5	46	52	7	8		-3			
65	102		246	213			10	119	98	47.5	46	50	7	8		-10			
64.5	97		241	213			12	127	97	47.5	46	51	7	8.5		-0			
65.5	93		246	213			14	139	102	47.5	46	51	8	9		2			
66	92		248	212.5			18	152	105	47.5	46	53	8	9		11			
66	117		250	212.5			23	131	109	47	46	52.5	8	8		11.5			
66	120		248	212.5			27	118	103	47	46	52.5	7.5	8		11			
64	92		240	212.5			22	115	101	47.5	46	53	7.5	8		17			
66	90		240	213			11	111	99	48	46	53.5	7.0	8		-2			
64	98		228	212			15	105	99	48	46	54	7	8		-1			

#9

		PRESSURES							WEIGHTS										
Time	Cont. Counter	Barometer	Boiler	Steam at Engine	Back	Condenser Ins. Hg	Ammonia Discharge	Ammonia Suction	Coal	Ash	Feed Water	Jacket Water	Condensed Steam	Cooling Water	Brine	Ice	Ammonia	Time of Pulling	
5:00	144	29.306	95	47			95	17									60		
5:30	144		83	47			95	17								102	59.5	5:35	
6:00	144		92	47			95	17									69.5		
6:30	144		90	47			95	17		73						103	62	6:35	
7:00	144		95	47			95	17											
7:30	144		80	47			95	17								104	74	7:35	
8:00	144		98	47			95	16											
8:30	144		90	47			95	15	400							103	71	8:35	
9:00	144		90	47			95	16											
9:30	144		90	47			100	17								104	66	9:35	
10:00	144		90	47			95	16											
10:30	144		90	45			102	17								103	71	10:35	
11:00	144		84	45			100	17											
11:30	144		75	47			100	16								105		11:35	
12:00	144		87	47			100	15											

Log Sheet No
Date 5/1/14
Shift 4-12M
Men on Shift
W. W.

TEMPERATURES

Room	Feed Water	Condensed Steam	Calorimeter		Jacket Water		Compressor Gas		Ammonia Condenser				Brine Around Ice Tanks		Brine Tank Ammonia Gas				
									Gas	Liquid	Cooling Water								
			Boiler	Engine	Inlet	Outlet	Inlet	Outlet			Inlet	Outlet	Inlet	Outlet	Inlet	Outlet			
64	96		228	212.5		~~12~~	12	93	93	49	46	53	7	8		0			
65	94		244	212			12	102	90	47.5	46	53	6	7		-1			
64	92		242	213			0	100	93	48	46	53	6	7		-1			
63	92		252	213.5			-1	100	91	48	46	53	6	7		-2			
63	90		252	213.5			-1	99	92	51	46	53	6	7		-1			
63	90		250	213			0	97	90	56	46	53	6	7		-1.5			
63	92		252	213			-2	108	93	48.5	46	53	6	6		-4			
63.5	90		254	212.5			3	114	96	48	46	53	5	6		-4			
64	88		246	214			+4	115	97	48	46	54	5	6		-3			
64	88		248	212.5			-2	64	98	48	46	64	5	6		-2			
64	90		248	213			-1	61	79	48	46	56	5	6		-1			
64	92		242	212.5			-1	62	76	48	46	55	5	6		-1.5			
64	97		244	211			-1	61	71	48	46	56	5	6		-1			
64	106		244	212			-1	88	71	48	46	56	5	6		-2			
64	104		244	212			6	120	84	47	46	56	5	6		-2			

#10

Time	Cont. Counter	PRESSURES							WEIGHTS										
		Barometer	Boiler	Steam at Engine	Back	Condenser Ins. Hg	Ammonia Discharge	Ammonia Suction	Coal	Ash	Feed Water	Jacket Water	Condensed Steam	Cooling Water	Brine	Ice	Ammonia	Time of Pulling	
12:30	R.P.M	29.306	89	48			95	11								104	63	12:35	
1:00	145		80	50			95	14	195								38		
1:30	145		87	52			96	16								104	45	1:00	
2:00	144		89	51			96	15								103	29	1:30	
2:30	144		86	50			96	15								104	25	2:00	
3:00	144		88	50			96	14	194							102	24	2:30	
3:30	144		88	45			95	5								103	28	3:00	
4:00	144		89	50			96	9		62.5						105	35	3:30	
4:30	144		75	53			105	13								105.5	30	4:00	
5:00	144		79	51			102	14								104	42	4:30	
5:30	144		76	52			100	15								104	51	5:00	
6:00	144		80	52			100	15								105	35	5:30	
6:30	144		93	52			100	15	162							105	22	6:00	
7:00	144		90	52			100	16								104	48	6:30	
7:30	144		92	52			103	16								106	83	7:00	
							100												

Log Sheet No
Date 5/2/14
Shift 12-8
Men on Shift
R. G. Bohn
H. C. Jumpe

TEMPERATURES

Room	Feed Water	Condensed Steam	Calorimeter		Jacket Water		Compressor Gas		Ammonia Condenser				Brine Around Ice Tanks		Brine Tank Ammonia Gas				
											Cooling Water								
			Boiler	Engine	Inlet	Outlet	Inlet	Outlet	Gas	Liquid	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet			
59	102		242	212			-1	137	91	48	46	54	4	6		-1			
59	102		244	212			15	150	98	48	46	55	4	6		-4			
59	100		244	212			15	135	102	48	46	55	6	9		-2			
59	98		244	212			11	115	102	53	46	57	6	7		-5			
59	100		240	212			10	114	99	52	46	56	6	6		-4			
59	98		232	212			8	112	97	51	46	56	6	7		-6			
57	100		240	212			16	102	94	50	46	55	6	7		-5			
55	100		242	212			9	106	93	48	46	53	6	6		-4			
56	100		239	212			15	140	92	49	46	53	5	6		-7			
55	98		240	212			11	121	92	48	46	55	6	7		-5			
60	97		242	212			13	140	92	48	46	56	6	6		-6			
60	100		240	212			18	160	96	48	46	57	6	6		-7			
63	104		240	212			20	146	100	48	46	56	7	7		-3			
63	106		242	212			24	142	96	46	46	56	7	7		-2			
64	98		244	212			2	58	92	55	46	58	8	8		6			

#11

		PRESSURES							WEIGHTS									
Time	Cont. Counter	Barometer	Boiler	Steam at Engine	Back	Condenser Ins. Hg	Ammonia Discharge	Ammonia Suction	Coal	Ash	Feed Water	Jacket Water	Condensed Steam	Cooling Water	Brine	Ice	Ammonia	Time of Pulling
8:00	144	29.29	92	53			100	20								105	32	8:30
8:30	144		97	53			100	18										
9:00			92	50			100	18								104	32	9:00
9:30	144		95	50			100	17	100							104	37	9:30
10:00			96	49			100	15								105	59	10:00
10:30	144		90	49			100	17	100							103	70	10:30
11:00			97	49			100	17								103	25	11:00
11:30			96	49			100	18								103	21	11:30
12:00	144		85	50			100	18		49						103	17.5	12:00

Log Sheet No

Date 5/2/14

Shift 8-12

Men on Shift

G. S. Cooley

R. G. Bohn

W. W. Lii

TEMPERATURES

			Calorimeter		Jacket Water		Compressor Gas		Ammonia Condenser				Brine Around Ice Tanks		Brine Tank Ammonia Gas	
											Cooling Water					
Room	Feed Water	Condensed Steam	Boiler	Engine	Inlet	Outlet	Inlet	Outlet	Gas	Liquid	Inlet	Outlet	Inlet	Outlet	Inlet	Outlet
60	112		244	212		1	1	60	91	59	46	57	8	9		2.5
64.5	116		212	212.5			1.5	75	44	52	46	52.5	8.5	10		1
65.5	110		244	212.5			1.5	110	74	56	46	57.5	7.5	9		1.5
64.5	109		243	212.5			6	125	89	51	46	57.5	8	9		0
66	108		246	212			12	140	93.5	48	46	56	8	9		0
67	109		248	212			12	143	100	51.5	46	57	8	9		5
67	98		242	212.5			17	152	105	51	46	57	8	9		2
69	106		244	212			17	156	108	51	46	57	9	10		2
67	106		242	212			10.5	159	110	51	46	57	9.5	10		2